

# HIGH EFFICIENCY GAS DOMESTIC WATER HEATERS

## PART 1 - GENERAL

### 1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract apply to this Section, including General and Supplementary Conditions and Division 01 Specification Sections.

### 2 SUMMARY

- A. This Section includes packaged, factory-fabricated and assembled, gas-fired, high efficiency condensing domestic water heaters, trim and accessories for generating hot potable water.

### 3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
- B. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of water heater.
- C. Shop Drawings: For water heaters, water heater trim and accessories, include:
  - 1. Elevations, sections, details
  - 2. Wiring Diagrams for power
- D. Operation and Maintenance Data: Data to be included in water heater emergency, operation and maintenance manuals.
- E. Warranty: Standard warranty specified in this Section.
- F. Buy America Certification

### 4 QUALITY ASSURANCE

- A. ETL Compliance. Condensing water heaters must be tested for compliance with ETL, "Commercial-Industrial Gas Heating Equipment." Condensing water heaters shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- B. NOx Emission Standards. When installed and operated in accordance with manufacturer's instructions.

### 5 COORDINATION

- A. Coordinate size and location of installation materials.

6 WARRANTY

- A. Standard Warranty: Water heaters shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of water heaters that fail in materials or workmanship within specified warranty period.
  - 1. Commercial Warranty Period for Condensing Water heaters:
    - a. The pressure vessel shall carry a 6 year from shipment, non-prorated, limited warranty against any failure due to waterside corrosion, mechanical defects, or workmanship. The heat exchanger shall carry a 6 year from commissioning, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects, or workmanship.
    - b. Manufacturer labeled control panels are conditionally warranted against failure for one (1) year from commissioning.
    - c. All other components, are conditionally guaranteed against any failure for 1 years from commissioning.

PART 2 - PRODUCTS

1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide Intellihot Model i200, Gen II; or a comparable product by one of the following:
  - 1. A.O. Smith Cyclone
  - 2. Triangle Tube Keystone Series
  - 3. Lochinvar Armor Series

2 CONSTRUCTION

- A. General: The water heating plant shall have a total recovery of \_\_\_\_\_ GPH, (\_\_\_\_\_ GPM) at a \_\_\_\_\_°F temperature rise. Each water heater shall incorporate a negative Pressure gas valve on each exchanger. Each unit shall operate with a minimum Combustion Efficiency of 98% at full fire.

\_\_\_\_\_ i200, Gen II each with an input of 199,950 BTU, output of 187,000 BTU, 228 GPH, (3.8 GPM) at 40-140 °F when fired with natural gas, turndown ratio 7:1, CO emissions of less than 400 ppm.) 1 - 199,950 Btu Heat Exchanger

- B. Description: Water heater shall be direct fired, fully condensing, water-tube design. Power burner shall have full modulation. The minimum firing rate shall not exceed 30,000 BTU/Hr input. Water heaters that have an input greater than 30,000 BTU/Hr at minimum fire will not be considered equal. The water heater shall have the capability of discharging into a positive pressure vent. Water heater thermal efficiency shall increase with decreasing load (output), while maintaining set point. Water heater shall have an operational set point capability of 90 °F to 185 °F and shall maintain the outlet temperature within an accuracy of +/- 2 °F during load changes of up to 100% rated capacity. Heater shall operate quietly, less than 55 dba. Water heater shall be factory-fabricated, factory-assembled and factory-tested, water-tube condensing water heater with heat exchanger sealed pressure-tight, built on a steel base, including a sealed insulated sheet metal enclosure that acts as combustion-air intake plenum.
- C. Heat Exchanger: The heat exchanger shall be constructed with 316L stainless steel helical water tubes, fully floating with no welded joints in the exchanger. The exchanger will have a single-pass combustion gas flow design. The water tubes shall be 3/4" ID, with no less than 0.0469" wall thickness.
- D. Hybrid Tank: The shell assembly of the hybrid tank vessel shall have a maximum water volume of less than .6 gallon. The water heater water connections shall be 3/4 inch Flanged O Ring connections. The shell assembly shall be constructed of 316L stainless steel of 0.0488 inch wall thickness or above.
- E. Modulating Air/Fuel Valve and Burner: The water heater burner shall be capable of a 7 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall be stainless fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. A variable frequency drive (VFD), controlled pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.
- F. The exhaust manifold shall be of PVC, CPVC, polypropylene, stainless steel (AL29-4C) with a 3 inch diameter flue connection.
- G. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

### 3 CONTROLS

- A. Refer to Division 23, Section "Instrumentation and Control of HVAC."
- B. The water heater control system shall be a Masterless Cascading design. Lead Lag – Master / Slave control systems will not be permitted. The entire system shall be ETL recognized.
- C. The control panel shall consist of one individual circuit board using state-of-the-art surface-mount technology in a single enclosure. The circuit boards shall include:
  1. A Digital touch display to indicate temperature and status
  2. A CPU board housing all control functions

Each board shall be individually field replaceable.

- D. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.
- E. The unit shall have a selectable exhaust temperature limit suitable for venting with PVC or CPVC/Polypropylene/Stainless Steel (AL29-4C).
- F. The controls shall annunciate water heater and sensor status and include extensive self-diagnostic capabilities.
- G. The water heater control system shall incorporate the following additional features for enhanced external system interface:
  - 1. Temperature set point
  - 2. High Exhaust temp monitor and control. Turn down the Gas valve until the exhaust temp is kept below selected material (PVC, CPVC).
  - 3. Cascading via RS232
  - 4. Error Code Display / Error Code History
    - a. Blower Fault
    - b. Blocked Flue Fault
    - c. Ignition Failure
    - d. Temp Sensor Short
    - e. Temp Sensor Wiring Fault
    - f. Flue Temp Fault
    - g. Heat Exchanger Temp Fault
    - h. Cascading Fault
    - i. Water Valve Fault
    - j. Pump Fault
    - k. Software Fault
  - 5. Monitor and access to daily, weekly, monthly water usages data.
  - 6. Monitor inlet/outlet temperatures, flow rates, flue gas temperatures, combustion rates via onboard touchscreen.
- A. Water Heater Management: the water heater control system shall incorporate onboard multi-unit sequencing logic that would allow Masterless Cascading (Not Lead/Lag – Master/Slave) functionality & sequencing between multiple water heaters operating in parallel and must have the following capabilities:
  - 1. Efficiently sequence 2 up to 10 heat exchangers on the same system to meet the load requirement.
  - 2. Individual heat exchanger logic to enable accurate temperature control.
  - 3. Operate one motorized valve per heat exchanger as an element of the load sequencing, Valves shall close with decreased load as heaters turn off, minimum of one (depending upon Mode selection) must always stay open for recirculation.

4. Automatically rotate Start/Stop amongst the heat exchangers in the chain based upon an internal calculation of run hours, water through put, burner starts and stops and length of time each burner has been firing. Sequencing is not based upon next in line (Lead/Lag), it is based upon the most logical (least used) heat exchanger in an effort to equalize unit run hours.
5. Automatic bump-less transfer of sequencing in case of heat exchanger failure. All systems must be able to fail all but one heat exchanger in any order or for any reason and the last will continue to operate.
6. Each heat exchanger will default to individual control upon failure of the sequencing chain.
7. Masterless control, change any parameter in any one of the units and all the rest in the series will automatically adjust to the most recent parameter change.

#### 4 ELECTRICAL POWER

- A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the water heater.
- C. Electrical Characteristics:
  1. Voltage: 120 V
  2. Phase: Single
  3. Frequency: 60 Hz
  4. Full-Load Current 3 Amps

#### 5 CONDENSATE

- A. Condensate traps, manufactured from only non-corrosive materials.
- B. Optional Accessory: Smart condensate neutralizer with capability of monitoring pH levels through included IoT app. Smart Neutralizer to also include:
  1. Monitor water temperatures
  2. CO detection, flue gas detection, water leak detection of boiler room w/ audible/visual alarms and alerts via app.
  3. Water flow recording/monitoring
  4. View history of above parameters via app.

## 6 VENTING

- A. The exhaust vent must be for use UL Listed for use with positive pressure, condensing flue gas service. Vents of PVC, CPVC, PP, SS (AL29-4C) must be used with water heaters.
- B. The minimum exhaust vent duct size for each water heater is three-inch diameter.
- C. Combustion-Air Intake: Water heaters shall be capable of drawing combustion air from the outdoors via a metal or PVC, CPVC or Polypropylene duct connected between the water heater and the outdoors.
- D. The minimum sealed combustion air duct size for each water heater is three-inch diameter.
- E. Common Vent and Common Combustion Air up to 10 heat exchangers. Consult manufacturer for common vent and combustion air sizing.

## 7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.
- B. Test and inspect factory-assembled water heaters, before shipping.,
- C. Allow Owner access to source quality-control testing of water heaters. Notify Architect fourteen days in advance of testing.

## PART 3 - EXECUTION

### 1 EXAMINATION

- A. Before water heater installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting water heater performance, maintenance and operations.
  - 1. Final water heater locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where water heaters will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 2 WATER HEATER INSTALLATION

- A. Install gas-fired water heaters in accordance with
  - 1. Local, state provincial, and national codes, laws, regulations, and ordinances.

2. National Fuel Gas Code, ANSI Z223.1/NFPA 54 – latest edition.
3. National Electrical Code, ANSI/NFPA 70 - latest edition.
4. Canada only: CAN/CGA B149 Installation Code and CSA C22.1 CEC Part 1.
5. Manufacturer's installation instructions, including required service clearances and venting guidelines.

- C. Assemble and install water heater trim.
- D. Install electrical devices furnished with water heater but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

### 3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to water heater to permit service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to water heater gas valve with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return water heater tapplings with shutoff valve and union or flange at each connection.
- F. Multiple heaters shall be piped such that all cold water entering the system will go through the heat exchanger first. A series of approved piping installation examples are shown in the installation and maintenance manuals provided with the unit. Each water heater shall have individual isolation valves for servicing and a hot water hose connection for start-up and field testing.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Water heater Venting
  1. Install flue venting kit and combustion-air intake.
  2. Connect venting full size to water heater connections. [Comply with requirements in Division 23 Section "Breechings, Chimneys and Stacks."]
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

#### 4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections
  - 1. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion, if necessary.
  - 4. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests

The water heater manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the water heater manufacturer to complete the following performance tests:

- 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
- 2. Water heaters shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
- 3. Perform field performance tests to determine capacity and efficiency of water heaters.
  - a. Test for full capacity.
  - b. Test for water heater efficiency at [low fire, 20, 40, 60, 80, 100, 80, 60, 40 and 20] percent of full capacity. Determine efficiency at each test point.

4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

END OF SECTION